International Journal of Applied Linguistics

WILEY

ORIGINAL ARTICLE

Multimodal Composition as a Catalyst for Technology Self-Efficacy

Junjie Gavin Wu[1] | Zi Yang[2] | Sangmin-Michelle Lee[3] | Mark Feng Teng[4]

[1]Faculty of Applied Sciences, Macao Polytechnic University, Macau | [2]Institute of Education, Xiamen University, Xiamen, China | [3]Department of Metaverse, Kyung Hee University, Yongin-si, South Korea | [4]Faculty of Languages and Translation, Macao Polytechnic University, Macau

Correspondence: Mark Feng Teng (markteng@mpu.edu.mo)

Keywords: ESP | implications | multimodal composing | semiotic resources | technology self-efficacy

关键词: 技术自我效能感 | 多模态写作 | 符号资源 | 专门用途英语 | 启示

ABSTRACT

In technological learning environments, technology self-efficacy (TSE) is a key to enhancing learners' learning perceptions and performances. The present paper examines the potential of multimodal composing, a pedagogical approach that allows learners to use different semiotic resources, in enhancing learners' TSE. This study employed a mixed-methods design to investigate the impact of multimodal composing on TSE among a group of English for Specific Purposes learners. The statistical analysis of both pre- and post-surveys revealed that the multimodal composing design had a measurable impact on students' TSE, with the three dimensions of magnitude, strength, and generalizability significantly improved after attending the course. The reflective data revealed more in-depth reasons for the students' improved TSE. The findings supported that hands-on engagement with multiple modes to create meaning in teaching and learning enhanced individuals' perceived confidence in accomplishing technology-mediated tasks. The paper concludes with implications for future research.

摘 要

在技术化学习环境中, 技术自我效能感(TSE)是提升学习者认知表现的关键要素。本文探讨多模态写作——一种允许学习者运用多种符号学资源的教学方法——在提升学习者技术自我效能感方面的潜力。本研究采用混合研究方法, 考察了多模态写作对特定用途英语(ESP)学习者技术自我效能感的影响。对前后测问卷的统计分析表明:多模态写作设计对学生的技术自我效能感产生了显著影响, 其强度、稳定性和普适性三个维度在课程结束后均获得显著提升。反思性数据进一步揭示了学生技术自我效能感提升的深层动因。研究结果证实:通过动手操作多种模态进行意义建构的教学实践, 能够有效增强个体完成技术中介任务的自信程度。文末提出了对未来研究的启示。

1 | Introduction

With the entry of the Web 3.0 era, the way of learning, working, and entertaining has been greatly inseparable from technology. Over the past two decades, educators across the disciplines have reached a basic consensus on the importance of the cultivation of learners' abilities to appreciate, apply, and evaluate technological tools for achieving different real-life purposes such as communication and learning. It has been theorized and understood as digital literacies (Pegrum et al. 2022). In recent years, due to the booming of new technologies such as generative artificial intelligence (GenAI), extended reality (XR), and blockchain, digital literacies have become even more important for learners to thrive in the current digitalized workplace (Wu 2024 2025). However, prior studies reported limited digital literacies of students in different educational levels in both developed (e.g.,

university students in Australia; Son et al. 2017) and developing countries (e.g., junior high school students in Iran; Dashtestani and Hojatpanah 2022). Among the various influencing factors such as the lack of infrastructure and technology and teacher resistance to technology, the psychological confidence and expectations in using the technology to meet learning needs, that is, technology self-efficacy (TSE), is a prerequisite to improve students' digital literacies (Getenet et al. 2024). According to Getenet et al. (2024), a positive student digital technology attitude can significantly contribute to digital TSE; however, the effect of digital technology literacy on self-efficacy for digital technologies was positive but not significant. Higher digital TSE consistently predicted greater engagement in all five areas: social, cognitive, behavioral, collaborative, and emotional engagement, supporting that TSE was linked to stronger engagement in suing technology to achieve learning goals.

Self-efficacy was first proposed by Bandura (1977) to describe one's beliefs about the capabilities to perform certain behaviors and to successfully complete tasks. Self-efficacy plays an essential part in promoting learners' self-regulated learning as it shapes the psychological states which further impacts the learning behavior (see a systematic review Ueno et al. 2025). Prior studies have pointed to the positive effects of strong levels of self-efficacy on improving motivation (Teng and Yang 2023), reducing anxiety (Teng 2024), and enhancing task performance (Alemayehu and Chen 2023; Getenet et al. 2024).

Literature has shown that when learning in a digital world, building up students' self-efficacy in using technology or TSE in learning is of prime importance to augmenting the quality of learning (Aldeeb et al. 2024; Teng 2024). High TSE steers learners in motivating, regulating, and deepening their own learning. Typically, learners who lack confidence in their ability to use technology may experience reduced motivation when using technology for learning purposes (Staddon 2023). In traditional, examination-oriented language classrooms in China, the grammar-translation approach with heavy reliance on the textbook-based instruction is still prevalent (Ji and Pham 2020). Especially in reading courses, passive learning is common as reading is often treated as a decoding exercise and the texts themselves tend to be outdated with little relevance to students' contemporary life (Xu et al. 2024). In addition, the use of digital tools has been perceived as distractions and even a waste of classroom time as rote memorization and visible grade improvement are deemed more important (Wu et al. 2025). However, this may put Chinese learners at a disadvantage since many of the tasks in the current and future workplace, especially when GenAI is here to stay, involve the effective, creative, and critical use of technology (Hao et al. 2024). To address the issue, this study attempted to innovate a traditional reading course to improve students' digital literacies, and more specifically, this paper focuses on the improvement of students' TSE. Digital literacy is widely recognized as a multifaceted construct that encompasses not only the technical skills required to operate digital tools, but also the cognitive, affective, and social competencies necessary to effectively navigate, evaluate, and create information in digital environments (Dashtestani, and Hojatpanah 2022). As such, digital literacy extends beyond mere functional abilities, involving attitudes, motivations, and self-efficacy in using technology (Son et al. 2017). Within this broader framework, TSE, defined as an individual's belief in their ability to successfully or confidently use digital technologies has been identified as a crucial affective component of digital literacy (Zou et al. 2025). TSE influences not only whether individuals engage with digital tools, but also how effectively they apply digital skills in learning contexts, and thus a focus of the present study.

Over the past decade, multimodal composing has become widely adopted in language courses to enhance language learners' digital literacies so as to prepare them for future job demands (Hafner and Miller 2011, 2019). Multimodal composing is a pedagogical attempt that encourages learners to make effective use of various semiotic resources to understand complex and abstract knowledge, create meaning, and apply the knowledge in the format of multimodal ensembles (Hafner and Miller 2019). This pedagogical strategy emphasizes the integration of multiple modes of input, text, like images, audio, video, gestures, and other modes of communication, to create meaning, enabling learners to make connections between different forms of knowledge and apply their understanding in diverse and creative ways. Prior research points out that multimodal composing not only demonstrates the potential in enhancing language skills, but also improves the understanding of semiotic resources and meaning making (Kim and Li 2021), identity development and voice expressions (Kim and Li 2021), learner autonomy (Hafner and Miller 2011), and learning motivations (Hava 2021). However, challenges also exist, including technology-induced distractions, negative attitudes toward the use of technology, and the lack of knowledge, skills, and strategies in coordinating different resources with meaning representations (Kim and Belcher 2020). In the present study, we report on the use of multimodal composing in transforming a traditional language course into a multimodal, collaborative course. In particular, the present paper investigates the effects of multimodal composing through the lens of TSE.

2 | Literature Review

With the wide acceptance and diverse applications of technology in education, self-efficacy has gained increasing popularity in the context of technology use in teaching and learning (Hodges 2018). The concept of self-efficacy has been extended to capture the new trend of technology-infused teaching and learning. For example, taking a social cognitive perspective, Compeau and Higgins (1995) extended the self-efficacy theory and presented the framework of computer self-efficacy (CSE). In their framework, CSE refers to individuals' beliefs in their ability to perform tasks with computers. Compeau and Higgins abstracted three distinct but interrelated dimensions from the construct of CSE, that is, magnitude, strength, and generalizability. The magnitude of CSE refers to the level of expected capability to perform a computer-related task. Students equipped with a high CSE magnitude are more likely to perceive themselves as capable of accomplishing difficult tasks, or alternatively, they require less assistance and support when undertaking a computer-related task. The dimension of strength reflects the "level of conviction about the judgment" (192) of their abilities to perform a task. Self-efficacy generalizability refers to the perceived ability to connect various computer systems and software packages to academic tasks.

Now, with the advancement of technologies, the scope of digital tools in learning has expanded beyond the use of computers. TSE in this case seems to be a broader and appropriate construct to define modern learning environments that are multimodal and synchronous in nature. TSE, according to Cassidy and Eachus (2002), is a major factor in understanding one's use of technology in accomplishing learning tasks. High TSE tends to contribute to reduced anxiety and increased motivation for learners while low TSE can lead to frustration and avoidance. Moreover, studies such as Namaziandost and Çakmak (2020) and Teng et al. (2023) have consistently pointed to a positive relationship between high TSE and better learning outcomes. Furthermore, TSE is context sensitive. For example, one can be confident in using mobile technology to improve English learning while demonstrating low levels of self-efficacy when using VR facility for English learning.

Among various influencing factors of TSE, previous positive experience with technology and perceived ease of use have been found closely related to the improvement of learners' confidence and willingness to use technology in learning (Hodges 2008). Yet, Cassidy and Eachus (2002, 135) reminded us that "it is the quality not the quantity of experience which is a critical factor in determining self-efficacy beliefs." In terms of other possible factors, researchers have reported that gender, age, characteristics, and educational levels jointly influence the development of TSE (Hanham et al. 2021; Kaarakainen et al. 2019). For example, educators such as Huffman et al. (2013) emphasized that the stereotyped roles of gender significantly impact a learner's TSE. Yet, researchers like Namaziandost and Çakmak (2020) have also suggested that through careful pedagogical support, negative TSE could be altered even when negative stereotypes were posed to female learners.

To improve TSE, Hodges (2008), informed by Bandura (1977), discussed four key sources:

1. *Enactive mastery experiences*: Not surprisingly, past and repeated successes tend to exert positive influence on learners' confidence and willingness toward learning and reducing negative feelings when completing a technology-related task. However, the situation is complicated by human memories and task difficulties. The effort required to complete a task mediates the level of self-efficacy. Memories may interfere with TSE. One typical example is that a learner may retain memories of fear about a difficult task despite the task being successfully accomplished (Bandura 1997). In addition, compared with simple tasks, the challenging ones may bring about more positive self-efficacy. However, when the task is far too difficult, learners may experience negative emotions and reduced levels of self-efficacy. Thus, Hendricks (2016, 33) suggested that "efficacy beliefs develop as habits … teachers can help students develop mastery over time by helping them prepare for and perform increasingly challenging tasks."
2. *Vicarious experience*: When a learner shares similar learning abilities, observations of success from others can be an effective approach for learners to develop their own self-efficacy (Hodges 2008). In particular, self-efficacy beliefs can be improved if success is achieved by people with different characteristics, that is, diversified modeling (Bandura 1977), after persistent effort. However, such a way of modeling is not as powerful as one's own performance accomplishments, especially when competitions exist in many exam-oriented classrooms (Hendricks 2016). In one recent study, Wilde and Hsu (2019) further suggested that one's existing levels of self-efficacy have a mediating role in interpreting the vicarious experience. Learners with lower levels of self-efficacy seemed to hold more negative comparisons than those with higher levels. Thus, special care should be provided to encourage low self-efficacy learners to develop more optimistic perspectives.
3. *Verbal persuasion*: This source mostly relies on suggestions and guidance from external parties such as teachers and peers, but the key issue is the trust between the learner and the persuader. Insincere and superficial encouragement can lead to counterproductive effects of unrealistic self-efficacy and failures (Hendricks 2016). Moreover, to provide effective verbal persuasion, attention must be paid to provide feedback "just beyond the capabilities of the receiver" (Hodges 2008, 16), which requires pedagogical expertise to scaffold learners based on their zone of proximal development.
4. *Affective states*: The formation of TSE is heavily impacted by emotional arousal such as fear, excitement, boredom, and enjoyment. Literature has suggested that positive mindset and feelings may lead to improved TSE, further enhancing physical learning behavior (Chang et al. 2014). On the contrary, negative emotions such as anxiety and fear may lead to low TSE, which can be overcome with appropriate guidance and encouragement from teachers through vicarious experience and verbal persuasion (Wilde and Hsu 2019). Similar to enactive mastery experiences, the difficulty of a task determines the level of arousal and "[a] modest level of arousal can increase attention and facilitate the use of skills" (Hodges 2008, 16).

In general, studies have demonstrated robust evidence of the positive correlation between technology-related self-efficacy and technology-based learning tasks (e.g., Chang et al. 2014; Pan and Chen 2021). Yet, most of the existing literature of TSE focuses on the context of online learning (e.g., Hanham et al. 2021) where learning usually happens in a one-way, transmissionist approach. In other words, learners tend to passively receive teacher instructions via online technology such as MOOCs and BlackBoard. Yet, such a mode of learning limits itself to the superficial dimensions of digital literacies in Hafner et al. (2015). As mentioned, multimodal composing may actively involve learners in the learning process and thus this study aims to examine the use of multimodal composing in relation to TSE. Moreover, many studies (e.g., Li and Kirkup 2007; Tam et al. 2020) have revealed a persistent gender bias in China's society that assumes female students are inferior to male students in technology-related tasks. Therefore, we are also interested in examining the gender factor that influences TSE. Specific questions are:

RQ 1: To what extent does multimodal composing affect students' TSE?
RQ 2: Are there any differences in the outcomes between gender groups?
RQ 3: What are the reasons for students' TSE change?

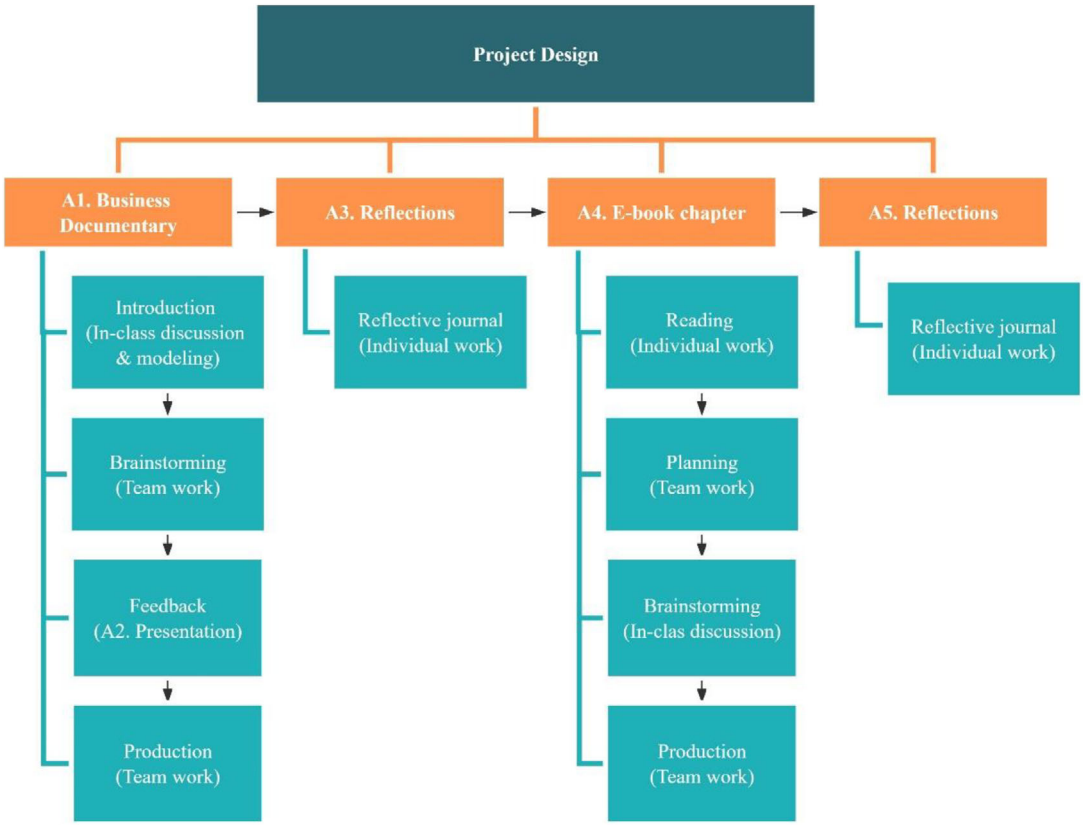

FIGURE 1 | Architecture of the course design. [Color figure can be viewed at wileyonlinelibrary.com]

3 | Method

3.1 | Research Design

English for Specific Purposes (ESP) education goes beyond the traditional linguistic drilling and practice by including a special focus on the development of content knowledge and skills. Business English is a common language major for Chinese students but the lack of macro-level guidelines, effective pedagogical practices, and appropriate assessment systems have plagued ESP teachers in China (Wang and Fan 2021). The study took place in a Business English Reading course at a regional university in Southern China. Figure 1 showcases the architecture of the course design, where "A" stands for "Assignments" that would be graded. Over the 18 weeks, in addition to the weekly in-class textbook learning, a large multimodal composing project, with two specific tasks (documentary and e-book chapter), was designed to extend student learning and deepen their understanding of the use of technology in learning. Working in small groups of three to four students, they were required to choose a business topic based on a unit from the textbook and to complete two learning tasks.

First, with some preparations about content and technology from the instructor, each group produced a documentary to introduce the self-selected business topic. Detailed steps are: (1) To scaffold students throughout the learning process, the instructor first held an orientation session by discussing the requirements and assessment criteria, recommending online resources, and showing sample documentaries produced by previous students. (2) After the session, the students worked together to brainstorm and draft a plan for their documentary task. (3) Students then via the format of a presentation shared their plans with the class and received constructive feedback from the audience. (4) Based on the feedback, each group produced a business documentary. The assessment criteria required students to introduce a topic in a deep, critical, and creative manner. Meanwhile, the final video product was assessed from a technological perspective, such as the background music, captions, and transition effects. Different technological tools were recommended to use by the teacher, such as iMovie, VivaVideo, and CapCut, and technical support was offered throughout the semester.

Second, based on the documentaries, the students were asked to co-compose e-book chapters by transferring what they had learned from the documentaries they produced. Again, students worked in groups and wrote a novel chapter to discuss the business concept from their videos. For example, one group wrote a fiction story based on several characters about the entertainment industry and virtual economy, touching upon aspects such as the definition, benefits, and shortcomings. To further support students in developing their digital literacies, students were encouraged to make use of multimodal resources to improve the readability of their e-chapters, such as including illustrations, video clips, and audio files. The purposes of this task included practicing writing skills, developing awareness of different semiotic resources and genres in speaking and writing, and developing creativity in collaborative learning.

The course was designed based on several considerations. First, informed by the key sources of enactive mastery experiences and

affective states, the course consists of a sequence of technology-related tasks that vary in difficulty. Each task requires the learners to apply what they have learned from the previous one. This way, the learners can gradually improve their technology skills and confidence. Second, the course design purposefully combines individual and collaborative work in technology-related tasks in order to provide vicarious experiences to learners and help them grow both personally and collectively. This design aims to foster a culture of learning from each other in a tech-savvy environment. In addition, contrary to the dominant role teachers tend to play in a Chinese classroom, the teacher in the present study played the role of facilitator by providing general guidance and support regarding technology, content, and language.

3.2 | Participants

A total of 91 first-year university students majoring in Business English took part in the project. Among the participants, there were 19 male students and 72 female students, with an average age of 18. All of these students successfully completed the Business English Reading course as part of their academic program. Based on their performance in the college entrance examination, they were assessed to be at an intermediate level of English proficiency, roughly equivalent to an IELTS score of 6.0. Prior to the course, the majority of the students were accustomed to traditional, textbook-based approaches to language instruction, which primarily focused on rote learning and structured exercises. While the participating students were familiar with basic digital tools for daily tasks (e.g., instant messaging apps, MS Word, and PowerPoint), none had any prior experience with sophisticated multimodal composition—such as creating documentaries or writing e-book chapters—making these tasks entirely novel and challenging for them. This lack of prior exposure to such creative and multimodal forms of learning highlighted the innovative nature of the project and provided a unique opportunity for students to step outside their comfort zones and engage with new methods of language learning and expression.

3.3 | Data Collection

A mixed-method approach was adopted in this study. The main data set consisted of pre- and posttests and student reflective journals, triangulated with teacher reflections and student learning portfolios. To answer RQ 1, a pretest–posttest design was adopted to measure the degree of change in students' TSE after attending the 18-week-long course. The surveys were administered at the beginning and the end of the course to measure students' TSE, based on a scale adopted and adapted from previous studies (Compeau and Higgins 1995; Wang 2010). Compeau and Higgins (1995) developed and validated a scale that includes 10 items to measure two dimensions of CSE in their framework, that is, magnitude and strength. Wang (2010) extended this original scale to a 16-item one to incorporate all three dimensions of the construct of CSE and recontextualized the scale to assess the beliefs of Chinese undergraduates in their capacity to complete academic tasks via computer. The structural equation modeling analysis indicated good psychometric properties attested by the excellent reliability and validity of the scale.

Building on the recontextualized scale, we modified the items by expanding the concept of CSE and using the concept of TSE instead to reflect the influx of new technologies (e.g., online video editor) in the field of second language education and aligning the scale with our teaching design. The scale includes 3 dimensions, that is, magnitude (5 items, e.g., "I can complete the task using technologies such as online video editor and VR facility if I have never used a similar one before"), strength (5 items, e.g., "If I use a familiar technology in a task and encounter unexpected difficulties, I can solve them with confidence"), and generalizability (4 items, e.g., "When a single task can be accomplished via different software packages, I am willing to make an effort to try different packages"). The scale was measured on a 6-point Likert scale of disagree to agree, with 1 standing for "disagree very strongly" and 6 for "agree very strongly" (item 6 is a reverse coded item).

To answer RQ 2, teacher and student reflections were collected. (1) The teacher kept a research journal over the project, noting down observations, reflections, and issues. Around 10,000 words were gathered. (2) Each student composed two reflective journals regarding the two learning tasks. Prompt questions were given to guide the students in focusing on the gains and challenges when completing the learning tasks and how their confidence in using technology for educational purposes has changed. In total, over 80,000 English words in 182 reflective journals were collected from the participants.

3.4 | Data Analysis

A paired *t*-test was conducted to evaluate the changes in TSE before and after the course, and to determine if improvements were observed in overall TSE as well as in the three specific dimensions. The paired *t*-test is a widely used statistical method for comparing the means of two related groups, such as pre- and post-intervention measurements, to assess whether a statistically significant difference exists (Field 2024). However, if the assumption of normality is not met, a non-parametric test, like the Wilcoxon signed-rank test, is used for comparing two related samples (e.g., pre- and posttest in the same group) (Field 2024). This approach is particularly valuable for measuring the change of TSE over time through comparing a pretest and a posttest in the same sample of participants.

Thematic analysis was adopted to understand the teacher and students' perceptions and experiences about the use of technology in completing language learning tasks. The analysis took the steps of reading the journals multiple times, locating important segments, generating labels, and organizing themes. Two researchers coded the student journals independently in NVivo, compared the results, and discrepancies were discussed and resolved.

4 | Results

4.1 | RQ 1: To What Extent Does Multimodal Composing Affect Students' TSE?

The study involved 91 undergraduates who attended the course and completed both the pretest and posttest surveys. Descriptive

TABLE 1 | Descriptive statistics.

Dimension	Pretest		Posttest	
	Mean	SD	Mean	SD
Magnitude	4.54	0.853	4.93	0.78
Strength	4.95	0.71	5.80	1.11
Generalizability	4.35	1.03	4.73	0.87

statistics in Table 1 seem to show an increasing trend from pretest to posttest for the three components of magnitude, strength, and generalizability. The internal consistency reliability of the overall scale and its subscales was assessed using Cronbach's α. In the pretest, the overall scale had a Cronbach's α of 0.94, with Cronbach's α of 0.83 for magnitude, 0.84 for strength, and 0.87 for generalizability. In the posttest, Cronbach's α of the overall scale was 0.89, and the values were found to be 0.87, 0.65, and 0.81 for the three subscales, respectively. Overall, the results indicate good internal consistency and reliability of the scale to measure TSE.

A paired *t*-test was used to analyze the pre-/post-survey differences in the mean scores for the three dimensions. We first checked the assumption of normality. The results based on the normality Test (Shapiro–Wilk) showed that the *p* value is less than 0.1, indicating the assumption of normality for the magnitude dimension is not met. In that case, we adopted Wilcoxon rank to understand the pretest–posttest differences. Results of the Wilcoxon signed-rank test indicated a statistically significant difference between the paired conditions of pretest and posttest ($W = 2621$, $p < 0.001$). The median difference was 2.00 (95% CI [1.50, 3.00]), with a large effect size as indicated by a rank-biserial correlation of 0.540. Again, the assumption for normality for the strength component is also not met. The non-parametric Wilcoxon signed-rank test corroborated similar findings of an increase from pretest to posttest ($W = 3415$, $p < 0.001$), with a median difference of 0.950 (95% CI [0.700, 1.15]). The rank-biserial correlation (0.705) further supported a large effect size. For the component of generalizability, the assumption of normality for the magnitude dimension is also not met ($p < 0.01$), for which we used Wilcoxon rank to interpret the results again. The non-parametric Wilcoxon signed-rank test confirmed these findings of showing an increase from pretest to posttest ($W = 2117$, $p = 0.002$), with a median difference of 0.500 (95% CI [0.125, 0.750]). The rank-biserial correlation (0.410) indicated a medium effect size.

4.2 | RQ 2: Are There any Differences in the Outcomes Between Gender Groups?

In order to ascertain the effectiveness of the multimodal composing design for different gender groups, paired *t*-tests were also conducted to compare the means of pre-/post-measurements for female and male students, respectively. However, the normality assumption for either male or female was also not met, for which we adopted Wilcoxon signed-rank test for comparison. The Wilcoxon signed-rank test ($W = 82.5$, $p = 0.794$) showed a median and non-significant difference of 0.100 (95% CI [−0.500, 0.600]) for the pretest of the component of magnitude when comparing male and female students. The non-parametric Wilcoxon signed-rank test yielded similar results for the posttest of magnitude ($W = 121$, $p = 0.132$), with a median difference of 0.400 (95% CI [−0.200, 1.000]) and a medium rank-biserial correlation ($r = 0.409$). These results suggest that while female students trended slightly higher than male students, the difference was not statistically significant.

For the pretest of the component of strength, the non-parametric Wilcoxon signed-rank test ($W = 82.5$, $p = 0.794$) showed a median difference of 0.125 (95% CI [−0.625, 0.875]) and a very weak effect (rank-biserial $r = 0.078$). These findings indicate that female and male students performed almost identically for this component of strength in the pretest even though female students demonstrated slightly higher scores. The Wilcoxon signed-rank test ($W = 121$, $p = 0.304$) showed a median difference of 0.400 with a weak association (rank-biserial $r = 0.274$), suggesting that while female students showed slightly higher values than male students, this difference was not statistically significant.

For the pretest of the component of generalizability, the Wilcoxon signed-rank test ($W = 79.5$, $p = 0.906$) showed a median difference effectively equal to zero (7.20e-5, 95% CI [−0.500, 0.875]) with minimal association ($r = 0.039$). These findings provide strong evidence for practical equivalence between male and female students even though female students demonstrated slightly higher scores. For the posttest of the component of generalizability, Wilcoxon signed-rank test ($W = 87.0$, $p = 0.965$, $r = 0.018$) showed trivial effect sizes and confidence intervals centered on zero for both mean (0.066, 95% CI [−0.682, 0.814]) and median (≈0.000, 95% CI [−0.750, 0.875]) differences. These results demonstrate practical equivalence between male and female students even though female students demonstrated slightly higher scores.

4.3 | RQ 3: What Are the Reasons for Students' TSE Change?

The analysis of 182 reflective essays uncovered four major driving factors of students' TSE improvement.

4.3.1 | Theme 1: Mastery Experiences and Skill Development

Learners greatly appreciated the challenging yet fruitful learning experience that led to future-oriented learning. According to the analysis, almost all the students referred to similar expressions of success, such as "finally did it," "final achievement," "we finally finished it!", and "we made it successfully at last." These emotive expressions provided some evidence that the participants in this study were able to develop a positive mindset at the end of the learning project since they firmly believed that major learning gains and results were achieved. Triangulated with the teacher's reflections, Han (pseudonyms used in this paper) shared that some students approached him near the end of the semester, expressing their increased confidence in their work. He wrote,

> Some groups came to me excitedly and shared they have made satisfactory documentaries. They asked me if I could pre-view their videos so they could further improve the quality.

Specifically, learners believed that the project provided a holistic learning experience of improving the English language, business knowledge, and technology skills. For example,

> I not only gained a lot of knowledge about economics, which helped me better understand the major of business English, but also developed some skills, such as video editing, PowerPoint production and so on. It is very meaningful to me and improved my ability. (Ma, reflection on documentary)

Based on the videos and e-chapters, the teacher reflected that his students produced sophisticated learning products, well applying their ESP knowledge within technological environments.

Though successful results were reported from the participants, the learning process was not always smooth. Problem-solving experiences were raised regarding producing PowerPoint slides, business documentaries, and e-chapters. According to the reflections, only a few students had prior video production experience (e.g., a short travelling video), but none of them had experience in editing a business documentary. Li, for example, shared that,

> None of us in my group had experience with video editing and production…But in the end really everyone learned a lot of new knowledge about video production, which will always be useful to us. (reflection on documentary)

Similar excerpts can be easily found throughout the student essays. It seemed that the lack of related technological experience did not profoundly prohibit learners from participating in the multimodal composing project. Instead, the participants witnessed progress in their technology knowledge and skills in this learning process, further reinforcing TSE beliefs.

In addition to the lack of related video production experience, the participants also encountered the hardship of speaking in front of cameras, selecting online information for video content, using various technological tools (e.g., how to dub a video), a logical and rational video structure, transferring words, statistics, and pictures into videos, and ensuring a nicely presented, appealing documentary. The participants, such as Zhao, shared her experience,

> The biggest challenge for me was that this was my first attempt to write a whole video script, so it's difficult for me to thinking about how to enrich the form and content of the video. (reflection on documentary)

Likewise, learners reflected that when writing up the e-chapter, they had to confront and resolve a variety of obstacles, among which coordinating multimodal semiotic resources to present their ideas coherently and cohesively was mentioned repeatedly by most of the students. For example,

> This was a novel experience and our teacher told us e-chapter should be different from a traditional chapter. This was taxing because we need to plan carefully and include pictures, links, sound, and other materials to make the chapter attractive. (Jian, reflection on e-chapter)

These problem-solving experiences jointly increased learners' confidence and willingness to integrate and try out other technologies in the future. Indeed, students remarked that they felt more prepared for and welcomed future technology-enhanced learning projects. Some examples are,

> [The project] allowed me to think about things more holistically, which lay a good foundation for our next group work. (Wang, reflection on documentary)

> I have been witnessing our progress with admiration, and I believe it will pave the way for a promising future! (Liu, reflection on e-chapter)

> … as contemporary college students, we should achieve all-round development and constantly improve our skills in all aspects, so as to prepare for entering the society in the future. (Gao, reflection on documentary)

Taken together, the reflections pointed to the students' enactive mastery experiences (see literature review), during which they encountered and resolved challenges related to the use of technologies to produce videos and e-chapters.

4.3.2 | Theme 2: Self-Directed Learning and Problem Solving

Self-directed learning was extensively reported in the reflections. As discussed, learners encountered challenges in completing the multimodal composing project, not only regarding the use of technology, but how to produce logical, deep, and meaningful videos. Yet, they reported that they were able to manage the problems and address them in an autonomous manner.

The participants reflected that to improve the content and presentation of the videos, they resorted to online video editing tutorials or attempted to mimic a similar documentary based on other popular documentaries.

> So we can only go online and watch videos of how others do it, and then learn the tutorial of video making. It took about a week just to find the right material and make a slideshow. (Yang, reflection on documentary)

> I watched a lot of economic and business videos to observe what they were made of…Therefore, our video was consisting of melodramas, interviews and animations. (Dai, reflection on documentary)

Yet, the restrictions of the internet presented themselves as a pervasive barrier to the participants. In their reflections, the students also highlighted the challenge of searching for appropriate English materials to overcome the internet restrictions in China. Students such as Kang, Sun, and Qian stressed that the lack of

YouTube resources remained unconstructive to their learning, though some of them were able to agentively circumvent the firewall to watch walkthroughs or samples on YouTube.

Likewise, without any e-chapter writing experience, the composition of the e-chapter motivated learners to proactively search for, critically read, and innovatively imitate other well-written chapters from the internet. Xiao, for example, commented,

> It was difficult to find suitable example in Chinese websites. I had to use other smart ways to get connected to Google and spent two weeks collecting and reading some examples. Luckily, I was able to develop some creative ideas for my group based on my online reading. (Shao, reflection on e-chapter)

However, rather than giving up, she managed to access Google and find the materials needed. It was evident that Shao invested a lot of extra effort in participating in this project and thus enhanced her experience and understanding of technology. Similar experiences were reported intensely among the student, which indeed provide strong evidence of student investment into their learning.

Similar out-of-class learning was evidenced in the reading lists submitted by the students, each group conducted extensive reading outside the class. Reading sources include English news, business reports, government reports, academic papers, YouTube and Bilibili videos, and laws.

4.3.3 | Theme 3: Collaboration and Peer Support

Data collected from student essays directed our attention to the significance of collaborative work in augmenting learners' TSE. Team work was a major feature of this learning project and the participants reported that suggestions, clarifications, mutual understanding, and peer and teacher support played vital parts in changing their psychological states in using technology in learning. According to the teacher's reflections, to better support the students, he conducted tutorial sessions at the onset of the project and provided counseling during the semester. For example, each group presented their ideas for the multimodal composing project and received feedback from the entire class and the teacher. Han commented,

> In those feedback sessions, we could always identify issues for each group, from the logic, presentation, materials, to the technical tools. It was definitely constructive to improving their confidence in using technology in learning. (reflection on e-chapter)

The student reflections revealed that communication and collaboration were key to the project. For example,

> My partner gave me a lot of advice over the term and accompanied me to shoot videos patiently, which enhanced our friendship. (Tang, reflection on documentary)

> Communication and cooperation were the key of this group work. Our team, which consisted 5 girls and only 1 boy, was facing hundreds of difficulties during the time when we collected the reference data and massed on the requirements of each team member. However, with our effective communication, mutual respect and friendly cooperation, difficulties were solved gradually. (Yu, reflection on documentary)

The reflections highlighted the role of team support and mutual trust over a relatively long period of time in supporting the participants in finishing up the learning tasks and enhancing their affective states toward the multimodal composing project.

Moreover, constructive feedback and suggestions were crucial to the improvement of student work, which in turn augmented their sense of achievement in this course.

> But after the feedback and reflection, our teachers, classmates and ourselves all found that our video had no highlight. So we listened to the opinions of the teachers and students, chose the tourism industry as the core example, and logged on to many tourism websites to survey the connection between the tourism industry and the single economy. In the process of consulting, combined with the actual situation, we also overturned the previously determined content so that our video content is more practical and more detailed. (Wei, reflection on documentary)

Wei's story was typical among the participants: they generally encountered obstacles in technology or content in the first few weeks, and then received guidance and encouragement from the teacher or peers throughout the semester, based on which they further polished and finalized their work. Throughout the 18 weeks, compared to individual student work, the participants received ongoing, external support, which seemed to well scaffold them in handling the difficulties and thus improved their TSE.

4.3.4 | Theme 4: Emotional Growth and Gender Dynamics

The participants reported enhanced levels of their affective states in participating in the multimodal work, including motivation, curiosity, enjoyment, confidence, and responsibility. Some representative examples are,

> …it broadened my horizon, sparked my passion and curiosity to explore how delectable and organized cartoons should be made, and I want to master the skills. (Jin, reflection on e-chapter)

> I learned a lot, and confident to say, I have developed my different skills, not just technological ones. (Pan, reflection on documentary)

> I spared no effort to cerebrate when I was in my position. I was one of the writers, translators and proofreader of the video. So when I drafted the script, I thought highly of it and thought about every word that I wrote. (Zhou, reflection on documentary)

However, the affective trajectories may not always be positive. Students like Zheng raised the interesting point that, compared to her male classmates, her gender prevented her psychologically at the beginning of the project. Yet, with her dedicated and continuous effort over the semester, she developed a sense of pride by completing her first video work.

> I never learn how to edit a video, so I search a lot on the Internet. From how to download Davinci to learn the process of editing, was all by myself. In the past, I always thought as a girl it's too difficult for me to learn how to edit a video, at the same time, learning such professional editing software also made me afraid…But when I look back to my first video work, a sense of pride arises from my heart. (reflection on documentary)

Similar to Zheng's comment, Cao talked about her experience of composing the e-chapter.

> As a girl we were not good at using technology as boys. I had no idea what a good e-chapter should have. But I tried my best during the course and my friends often helped me. (reflection on e-chapter)

Indeed, the teacher was also concerned about the gender role in negatively impacting student participation. Yet, as the project continued, his worries were relieved,

> I was very much worried that the female students would avoid making effort because of the stereotype of girls disliking any tech elements. However, based on my observations, most of them very actively contributed their knowledge and skills in making the video or writing the e-chapter. (reflection on e-chapter)

It seemed that gender stereotype could be a hindering element in influencing the students' affective states at the beginning of the project, but later on, the negative emotions were altered with their determinations and peer support in learning.

5 | Discussion

The statistical analysis of both pre- and post-surveys revealed that the students in general had an above-average level of TSE. The Wilcoxon signed-rank test results demonstrated that the multimodal composing design had a measurable impact on students' TSE, with the three dimensions of magnitude, strength, and generalizability significantly improved.

The results supported non-significant differences between male and female students, even though female students demonstrated slightly higher scores in the three dimensions. Students' TSE improved due to four key factors identified in 182 reflections: mastery experiences, self-directed learning, collaboration, and emotional growth.

Notably, the male participants' TSE scores trended upward, indicating positive shifts in their self-perceptions of technological ability. Their engagement with the multimodal composing project, through documentary production and e-chapter writing, still offered opportunities for mastery experiences and self-directed learning, both of which are known to strengthen TSE (Bandura 1997; Hodges 2008). Although male students may not have voiced the same degree of psychological barriers, and partly due to the smaller number, as some female participants, the reflective data indicate that they, too, encountered and overcame challenges related to technical tools, content organization, and multimodal coordination.

The findings aligned with several previous studies (e.g., Abdelhalim 2024) which showed that active engagement with multimodal tasks such as multimodal composing can improve learners' confidence in participating in technology-mediated learning. The results showed overall small to moderate improvements in the three dimensions (Cohen 1988), and the largest effect size for the dimension of magnitude among the three indicated that students saw the biggest difference in the level of task difficulty that they believed they can attain. Although the three dimensions did not achieve a larger effect size, the multimodal composing design is still perceived as an effective way of improving students' TSE, considering the improvements achieved within the 5-month course.

The reflective data revealed more in-depth reasons for the students' improved TSE. First, the fruitful learning experience is crucial in shaping students' TSE. In test-dominated societies like China, rote learning, including drilling and memorization, tends to play a dominant role in most students' lived experiences (Wu and Miller 2021). Learners quite often place their sole emphasis on scores. Yet, such a way of learning has been criticized for the lack of in-depth, critical, and autonomous learning that empowers learners as lifelong learners. In line with the argument of Han and Geng (2023), the present study pointed to the quality of technology-enhanced learning in determining learners' TSE. In this multimodal composing project, the teacher downplayed his direct impact on students' learning trajectories, but instead the student participants took on an active part in the hands-on, holistic learning experience of understanding, exploring, constructing, and sharing knowledge via diverse digital semiotic resources. Compared to the traditional textbook-based learning, students' attention was shifted from the product to the process of learning, during which they increased their motivation for participation and took charge of their own learning through technology (similar results in Hafner and Miller 2011).

Moreover, the findings showed that students benefited from their problem-solving experiences, which helped to enhance their resiliency in the face of learning challenges, thereby preparing them mentally and technologically for future technology-enhanced learning. This result contradicts the findings from

Getenet et al. (2024) where they reported no correlation between TSE and engagement. Rather, the present study suggested that the multimodal composing project increased learners' TSE and motivated them to engage in learning, and in return, they further increased TSE. This could be attributed to the design of the project: Based on Hendricks (2016), the development of TSE is more productive with learning tasks are slightly above learners' current zone of proximal development. As Moos and Azevedo (2009, 587) argue, mastery experiences that emerged from simple tasks may be ineffective in developing students' TSE since students may hold "unrealistic expectations of similar results in the future."

Though problem-solving experiences are constructive in improving TSE, modeling from online resources and external support from the teacher and peers cannot be overlooked. Learning modeling is an essential source of learners' TSE. According to the reflections, to accomplish the learning tasks, the participants resorted to different online resources such as YouTube videos and these learning practices aligned with our current learning theories, such as constructivism, where students observe, imitate, and extend learning based on models (Hodges 2008). However, educators such as Compeau and Higgins (1995) have cautioned that the use of behavioral modeling may not be useful if not carried out with direct learning experiences to reinforce learning. Also, the choice of models can significantly impact the TSE. In other words, in this study, whether a learner can find an appropriate, relevant YouTube video to imitate can influence the level of TSE. If the model was too complex for learners to follow, an avoidance strategy could be adopted. Thus, to support learners in managing difficulties, external support was important in the multimodal composing project, helping students improve TSE instead of adopting the avoidance strategy.

As Cassidy and Eachus (2002) argued, when facing obstacles, it is not uncommon for students to choose to avoid participating in study; however, the students in this project shared that they actively sought help and guidance from the teacher and groupmates and made a serious attempt in completing those tasks. This may also be partly due to the collectivist mindset of shared effort (Smith and Hung 2017) that Chinese learners tend to ascribe success to collective effort, and thus external support can be extremely vital. Compared to short-term projects, external support over a prolonged time period may help students develop their affective acceptance.

Though verbal persuasion from others has been argued as a powerful tool in increasing TSE, simple encouragement alone is not as useful as constructive feedback, strategy instruction, and metacognitive support (Marakas et al. 1998). Prior research has suggested the positive effects of feedback, strategy, and metacognition in relation to TSE improvement (Wu et al. 2024; Chang et al. 2022; Wilde and Hsu 2019). These effects were also corroborated in our study since students reported extensively about their learning gains from the teacher and peer learners.

Finally, gender stereotypes seem to play an important part in the beginning of learning, but they could be altered through learning experiences. Although findings are mixed about the relationship between gender and TSE, studies generally suggest the lower levels of TSE for females than males (Hanham et al. 2021). Likewise, female students in this study extensively reported their concerns about using technology in learning, especially when they had never participated in a multimodal composing project. Findings from the survey and reflections suggested that some female learners were bothered by the psychological barriers posed by the gender stereotype that females may not be adept at technology. However, interestingly, their concerns were alleviated with their devotion, effort, and successful learning experience. Possible reasons include their active use of regulatory strategies and external support, and encouragement over a long process. This finding is in line with Dunlap (2005), who reported a similar case with learners undergoing a TSE change from low to high in a problem-solving learning project.

6 | Conclusion

This study presents a pioneering attempt at using multimodal composing to promote TSE. Overall, the findings contribute to the theoretical understanding of TSE. TSE was shaped by dimensions like magnitude (perceived difficulty level achievable), strength (resilience in overcoming challenges), and generalizability (application across contexts). The multimodal composing project, which replaced rote learning with hands-on, process-oriented tasks, significantly boosted students' TSE, especially among females, who initially faced gender-related psychological barriers. Improvements stemmed from active problem solving, exposure to slightly challenging tasks within their proximal development, and sustained external support (e.g., peer collaboration and teacher feedback). Constructive metacognitive strategies and modeling from online resources further reinforced TSE, while collectivist values and prolonged engagement allowed students to reframe gender stereotypes and internalize success through effort. We argue for the need to prioritize mastery experiences (hands-on task success) and social modeling, while emphasizing structured scaffolding and iterative feedback mechanisms that transcend superficial encouragement. This approach aligns with TSE theory's emphasis on gradual skill internalization through guided challenges and peer/mentor collaboration, rather than relying on passive motivational strategies.

An important limitation of the study is that it did not include experimental and control groups. Instead, the study only compared the same group of participants before and after the course. This design limits the researchers' ability to attribute changes in the participants' performance to the intervention, as other factors may have influenced the TSE. Another limitation is that the study relied on self-reported data, which can be subjective as they are self-reported accounts of students' experiences. This subjectivity may introduce bias into the research findings and limit their reliability, though emic, in-depth perspectives were gathered in this study.

Though the study has the abovementioned issue, it provides some practical implications for language educators and learners. First, meaningful exposure to technology and problem-solving experience are useful to improve learners' TSE. The present study invited the participants to utilize various technologies for 18 weeks, during the process, they encountered and overcame difficulties and developed future-oriented expectations of using technology for learning. Thus, rather than create unchallenging

environments for students, teachers perhaps could consider the complex intersections between learning and technology. Second, when placing learners within out-of-class, technological learning environments, external support from teachers, classmates, and the internet should be emphasized. In particular, to learners with little prior technological contact, special and ongoing help may enable learners to better cope with learning challenges and improve their TSE. Third, in contexts like China, where exams and rote learning are prioritized, the implementation of such innovative pedagogical practices remains challenging. While teacher agency plays a pivotal part, the reality is that many teachers lack the necessary expertise to design and execute such transformative approaches. It highlights the vital need for targeted professional training to equip teachers with updated pedagogical knowledge and practical skills. Last, though inclusive, attention should be given by teachers to help learners get over with their psychological barriers, especially their gender perceptions. Successful learning experiences together with behavioral modeling and teacher/peer support hopefully contribute to the learners' development of TSE and further enhance their learning performance within technology-enhanced learning tasks.

Ethics Statement

This study was supported by Macao Polytechnic University (Research grant: Incubating Emerging Technologies for Language Teaching and Learning, Grant number: RP/FLT-03/2025).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Peer Review

The peer review history for this article is available at https://publons.com/publon/10.1111/ijal.12860.

References

Abdelhalim, S. M. 2024. "From Traditional Writing to Digital Multimodal Composing: Promoting High School EFL Students' Writing Self-Regulation and Self-Efficacy." *Computer Assisted Language Learning* 1–30.

Aldeeb, F. H., O. M. Sallabi, M. M. Elaish, and G. J. Hwang. 2024. "Enhancing Students' Learning Achievements, Self-Efficacy, and Motivation Using Mobile Augmented Reality." *Journal of Computer Assisted Learning* 40, no. 4: 1823–1837.

Alemayehu, L., and H. L. Chen. 2023. "The Influence of Motivation on Learning Engagement: The Mediating Role of Learning Self-Efficacy and Self-Monitoring in Online Learning Environments." *Interactive Learning Environments* 31, no. 7: 4605–4618.

Bandura, A. 1977. "Self-Efficacy: Toward a Unifying Theory of Behavioral Change." *Psychological Review* 84, no. 2: 191–215. https://doi.org/10.1037/0033-295X.84.2.191.

Bandura, A. 1997. *Self-Efficacy: The Exercise of Control*. W. H. Freeman.

Cassidy, S., and P. Eachus. 2002. "Developing the Computer User Self-Efficacy (CUSE) Scale: Investigating the Relationship Between Computer Self-Efficacy, Gender and Experience With Computers." *Journal of Educational Computing Research* 26, no. 2: 133–153. https://doi.org/10.2190/JGJR-0KVL-HRF7-GCNV.

Chang, C. Y., P. Panjaburee, H. C. Lin, C. L. Lai, and G. H. Hwang. 2022. "Effects of Online Strategies on Students' Learning Performance, Self-Efficacy, Self-Regulation and Critical Thinking in University Online Courses." *Educational Technology Research and Development* 70: 1–20.

Chang, C.-S., E. Z.-F. Liu, H.-Y. Sung, C.-H. Lin, N.-S. Chen, and S.-S. Cheng. 2014. "Effects of Online College Student's Internet Self-Efficacy on Learning Motivation and Performance." *Innovations in Education and Teaching International* 51, no. 4: 366–377. https://doi.org/10.1080/14703297.2013.771429.

Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Routledge.

Compeau, D. R., and C. A. Higgins. 1995. "Computer Self-Efficacy: Development of a Measure and Initial Test." *MIS Quarterly* 19, no. 2: 189. https://doi.org/10.2307/249688.

Dashtestani, R., and S. Hojatpanah. 2022. "Digital Literacy of EFL Students in a Junior High School in Iran: Voices of Teachers, Students and Ministry Directors." *Computer Assisted Language Learning* 35, no. 4: 635–665. https://doi.org/10.1080/09588221.2020.1744664.

Dunlap, J. C. 2005. "Problem-Based Learning and Self-Efficacy: How a Capstone Course Prepares Students for a Profession." *Educational Technology Research and Development* 53, no. 1: 65–83. https://doi.org/10.1007/BF02504858.

Field, A. 2024. *Discovering Statistics Using IBM SPSS Statistics*. Sage.

Getenet, S., R. Cantle, P. Redmond, and P. Albion. 2024. "Students' Digital Technology Attitude, Literacy and Self-Efficacy and Their Effect on Online Learning Engagement." *International Journal of Educational Technology in Higher Education* 21, no. 1: 3.

Hafner, C. A., A. Chik, and R. H. Jones. 2015. "Digital Literacies and Language Learning." *Language Learning & Technology* 19, no. 3: 1–7. https://doi.org/10.64152/10125/44256.

Hafner, C. A., and L. Miller. 2011. "Fostering Learner Autonomy in English for Science: A Collaborative Digital Video Project in a Technological Learning Environment." *Language Learning & Technology* 15, no. 3: 68–86. https://doi.org/10.64152/10125/44256.

Hafner, C. A., and L. Miller. 2019. *English in the Disciplines: A Multidimensional Model for ESP Course Design*. Routledge.

Han, J., and X. Geng. 2023. "University Students' Approaches to Online Learning Technologies: The Roles of Perceived Support, Affect/Emotion and Self-Efficacy in Technology-Enhanced Learning." *Computers & Education* 194: 104695.

Hanham, J., C. B. Lee, and T. Teo. 2021. "The Influence of Technology Acceptance, Academic Self-Efficacy, and Gender on Academic Achievement Through Online Tutoring." *Computers & Education* 172: 104252. https://doi.org/10.1016/j.compedu.2021.104252.

Hao, Z., F. Fang, and J.-E. Peng. 2024. "The Integration of AI Technology and Critical Thinking in English Major Education in China: Opportunities, Challenges, and Future Prospects." *Digital Applied Linguistics* 1: 2256. https://doi.org/10.29140/dal.v1.2256.

Hava, K. 2021. "Exploring the Role of Digital Storytelling in Student Motivation and Satisfaction in EFL Education." *Computer Assisted Language Learning* 34, no. 7: 958–978.

Hendricks, K. S. 2016. "The Sources of Self-Efficacy: Educational Research and Implications for Music." *Update: Applications of Research in Music Education* 35, no. 1: 32–38. https://doi.org/10.1177/8755123315576535.

Hodges, C. B. 2008. "Self-Efficacy in the Context of Online Learning Environments: A Review of the Literature and Directions for Research." *Performance Improvement Quarterly* 20, no. 3-4: 7–25. https://doi.org/10.1002/piq.20001.

Hodges C. B., ed. 2018. *Self-Efficacy in Instructional Technology Contexts*. Springer.

Huffman, A. H., J. Whetten, and W. H. Huffman. 2013. "Using Technology in Higher Education: The Influence of Gender Roles on Technology Self-Efficacy." *Computers in Human Behavior* 29, no. 4: 1779–1786. https://doi.org/10.1016/j.chb.2013.02.012.

Ji, Y., and T. Pham. 2020. "Implementing Task-Based Language Teaching (TBLT) to Teach Grammar in English Classes in China: Using Design-Based Research to Explore Challenges and Strategies." *Innovation in Language Learning and Teaching* 14, no. 2: 164–177.

Kaarakainen, M.-T., L. Saikkonen, and J. Savela. 2019. "Information Skills of Finnish Basic and Secondary Education Students: The Role of Age, Gender, Education Level, Self-Efficacy and Technology Usage." *Nordic Journal of Digital Literacy* 13, no. 4: 56–72. https://doi.org/10.18261/issn.1891-943x-2019-04-05.

Kim, D., and M. Li. 2021. "Digital Storytelling: Facilitating Learning and Identity Development." *Journal of Computers in Education* 8: 33–61. https://doi.org/10.1007/s40692-020-00173-6.

Kim, Y., and D. Belcher. 2020. "Multimodal Composing and Traditional Essays: Linguistic Performance and Learner Perceptions." *RELC Journal* 51, no. 1: 86–100. https://doi.org/10.1177/0033688219886538.

Li, N., and G. Kirkup. 2007. "Gender and Cultural Differences in Internet Use: A Study of China and the UK." *Computers & Education* 48, no. 2: 301–317. https://doi.org/10.1016/j.compedu.2004.11.007.

Marakas, G. M., M. Y. Yi, and R. D. Johnson. 1998. "The Multilevel and Multifaceted Character of Computer Self-Efficacy: Toward Clarification of the Construct and an Integrative Framework for Research." *Information Systems Research* 9, no. 2: 126–163. https://doi.org/10.1287/isre.9.2.126.

Moos, D. C., and R. Azevedo. 2009. "Learning With Computer-Based Learning Environments: A Literature Review of Computer Self-Efficacy." *Review of Educational Research* 79, no. 2: 576–600. https://doi.org/10.3102/0034654308326083.

Namaziandost, E., and F. Çakmak. 2020. "An Account of EFL Learners' Self-Efficacy and Gender in the Flipped Classroom Model." *Education and Information Technologies* 25, no. 5: 4041–4055. https://doi.org/10.1007/s10639-020-10167-7.

Pan, X., and W. Chen. 2021. "Modeling Teacher Supports Toward Self-Directed Language Learning Beyond the Classroom: Technology Acceptance and Technological Self-Efficacy as Mediators." *Frontiers in Psychology* 12: 751017.

Pegrum, M., N. Hockly, and G. Dudeney. 2022. *Digital Literacies*. 2nd ed. Routledge.

Smith, C. S., and L.-C. Hung. 2017. "Using Problem-Based Learning to Increase Computer Self-Efficacy in Taiwanese Students." *Interactive Learning Environments* 25, no. 3: 329–342. https://doi.org/10.1080/10494820.2015.1127818.

Son, J.-B., S.-S. Park, and M. Park. 2017. "Digital Literacy of Language Learners in Two Different Contexts." *JALT CALL Journal* 13, no. 2: 77–96. https://doi.org/10.29140/jaltcall.v13n2.213.

Staddon, R. V. 2023. "Exploring Higher Education Students' Perspectives on Factors Affecting Use, Attitudes and Confidence With Learning Technologies." *International Journal of Instruction* 16, no. 2: 31–52.

Tam, H., A. Y. Chan, and O. L. Lai. 2020. "Gender Stereotyping and STEM Education: Girls' Empowerment Through Effective ICT Training in Hong Kong." *Children and Youth Services Review* 119: 105624. https://doi.org/10.1016/j.childyouth.2020.105624.

Teng, M. F., C. Wang, and J. G. Wu. 2023. "Metacognitive Strategies, Language Learning Motivation, Self-Efficacy Belief, and English Achievement During Remote Learning: A Structural Equation Modelling Approach." *RELC Journal* 54, no. 3: 648–666.

Teng, M. F., and Z. Yang. 2023. "Metacognition, Motivation, Self-Efficacy Belief, and English Learning Achievement in Online Learning: Longitudinal Mediation Modeling Approach." *Innovation in Language Learning and Teaching* 17, no. 4: 778–794. https://doi.org/10.1080/17501229.2022.2144327.

Teng, M. F. 2024. "Do Self-Efficacy Belief and Emotional Adjustment Matter for Social Support and Anxiety in Online English Learning in the Digital Era?" *Digital Applied Linguistics* 1: 2227.

Teng, M. F. 2025. "Metacognition, Self-Efficacy Belief, Language Learning Motivation, and Perceived Progress in Online English Learning: A Cross-Lagged Analysis." *International Journal of TESOL Studies* 7, no. 1: 4–29. https://doi.org/10.58304/ijts.20250102.

Ueno, S., O. Takeuchi, and Y. Shinhara. 2025. "Exploring the Studies of Self-Regulated Learning in Second/Foreign Language Learning: A Systematic Review." *International Journal of TESOL Studies* 7, no. 1: 126–147. https://doi.org/10.58304/ijts.20250108.

Wang, J. 2010. "Daxuesheng Jisuanji Ziwo Xiaonenggan Wenjuan de Kaifayu Yingyong [The Development and Validation of the Scale of Computer Self-Efficacy of University Students]." *Open Education Research* 16, no. 2: 90–97.

Wang, L., and J. Fan. 2021. *Core Issues in Business English Education in China*, 1–8. Springer.

Wilde, N., and A. Hsu. 2019. "The Influence of General Self-Efficacy on the Interpretation of Vicarious Experience Information Within Online Learning." *International Journal of Educational Technology in Higher Education* 16, no. 1: 1–20. https://doi.org/10.1186/s41239-019-0151-4.

Wu, J. G., and S. M. Lee. 2025. "Immersive literacy." In *The Palgrave Encyclopedia of Computer-Assisted Language Learning*, edited by M. Pegrum. and A. Alm. Palgrave.

Wu, J. G., and L. Miller. 2021. "Raising Native Cultural Awareness Through WeChat: A Case Study With Chinese EFL Students." *Computer Assisted Language Learning* 34, no. 4: 552–582.

Wu, J. G., L. Miller, and F. Teng. 2025. "Engagement and Incidental L2 Vocabulary Acquisition in Digital Gaming: A Qualitative Perspective of an in-denial Gaming Addict From Hong Kong." *International Journal of Applied Linguistics*.35: 1469–1481. https://doi.org/10.1111/ijal.12712.

Wu, J. G., D. Zhang, and S. M. Lee. 2024. "Into the Brave New Metaverse: Envisaging Future Language Teaching and Learning." *IEEE Transactions on Learning Technologies* 17: 44–53.

Wu, J. G., and S. M. Lee. 2025. "Immersive Literacy." In *The Palgrave Encyclopedia of Computer-Assisted Language Learning*, edited by M. Pegrum, and A. Alm. Palgrave.

Xu, N., S. Xiong, and Y. Kong. 2024. "Unveiling English Reading Literacy: Insights From Senior High School Students in Chongqing, China." *SAGE Open* 14, no. 3: 21582440241281413.

Zou, D., H. Xie, and L. Kohnke. 2025. "Navigating the Future: Establishing a Framework for Educators'. Pedagogic Artificial Intelligence Competence." *European Journal of Education* 60, no. 2: e70117.